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(54) **BALANCE STRUCTURE OF MOTOR.**

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Description

The present invention relates to the construction of a general-purpose industrial electric motor, by which the vibration and noise are reduced, and more particularly, to a motor balancing structure for balancing such an electric motor.

The increases in the machining speed in the field of machine tools have led to problems such as a lowering of the machining accuracy due to the vibration of the electric drive motors used for driving the spindle and other movable components of a machine tool, and an increase of the noise therefrom. It is considered that the vibration of an electric motor can be most effectively reduced by correcting an unbalanced state of each rotating component of the electric motor.

Therefore, in the conventional procedure for assembling an electric motor, the respective rotating components of the motor are first balanced to thereby obtain a well-balanced final product as the electric motor.

In a very-high speed motor operating at a maximum rotational speed of more than 15,000 r.p.m., however, even a very small imbalance therein can cause detrimental vibration and noise when the motor operates in the high-speed range. Namely, if the rotating components of an electric motor are balanced individually and the components are then assembled, very small imbalances remaining in the components may accumulate to form an imbalance that exceeds an allowable limit.

Even if it is intended to complete the construction of the motor by pre-assembling the rotating components thereof and balancing same before combining the balanced rotating components with a motor casing and associated parts, it is frequently impossible to carry out such an assembling process due to structural restrictions, and even if it is possible to assemble the motor by such assembling method, a problem arises in the quality control of the motor. For example, it is necessary to take the bearings to pieces, to attach only the inner rings to the output shaft of the motor, and to reassemble the bearings after balancing the combination of the output shaft and the inner rings. Such a method requires much time and labor, and unavoidably gives rise to problems such that the bearings are contaminated with dust. Furthermore, the parts and components of the motor must be mounted on an external drive means of a commercial balancing machine, to be dynamically balanced individually, but since the external drive means of the commercial balancing machine can rotate the parts only at 3,000 r.p.m. at most, the commercial balancing machine is incapable of detecting a small imbalance thereof.

Accordingly, an object of the present invention is to provide a low cost, balanced motor structure capable of balancing a motor so that the motor is able to

operate in a well-balanced state over the entire operating speed range.

DE-A-5270422 and FR-A-2461855 both disclose balancing rings which also act as seal members.

US-A-2249834 discloses an apparatus comprising an electric motor having a rotating output shaft provided with axially opposite external ends and a balancing structure comprising a respective disk member fixedly attached to each end of the output shaft, each of the disk members having axially inner and outer surfaces formed perpendicular to the axis of rotation of the output shaft; and according to the present invention, such an apparatus is characterised by the axially outer surfaces of each of said disk members having defined thereon a plurality of internally threaded holes, the plurality of internally threaded holes being externally exposed so as to enable an operator to access the plurality of internally threaded holes, at least one of the disk members being a labyrinth seal; and a plurality of balancing screws of different lengths, wherein, in use, one of the screws is interchangeably screwed into a corresponding internally threaded hole in one of the two disk members, for interchangeably balancing the output shaft of the electric motor.

This enables a dynamic balance of an electric motor to be obtained through a measurement of an imbalance while the assembled motor is rotated under its own drive power on a commercial balancing machine marketed as a field balancing machine. The imbalance is then eliminated by screwing the balancing screw, from outside the motor, into the internally threaded hole of the labyrinth seal-defining structural member and optionally the rotational speed detecting gear, to an appropriate point. Since the motor can be balanced at both the front and rear ends, to obtain a two-point balance, the motor can be accurately dynamically balanced.

In the accompanying drawings:

Fig. 1 is a longitudinal sectional view of an electric motor incorporating therein a dynamic balancing structure according to a first embodiment of the present invention;

Fig. 2 is a front view of a structural member forming a labyrinth seal, as viewed in the direction of an arrow A or B in Fig. 1;

Fig. 3 is a longitudinal sectional view of an electric motor incorporating therein a dynamic balancing structure according to a second embodiment of the present invention;

Fig. 4 is a front view of a gear member used for detecting a rotational speed of the motor, as viewed in the direction of the arrow C in Fig. 3; and

Fig. 5 is a longitudinal sectional view of another electric motor incorporating therein a dynamic balancing structure similar to that shown in Fig. 1.

The present invention will be described herein-after with reference to preferred embodiments thereof as illustrated in the accompanying drawings.

Referring to Fig. 1, a front bearing 20F and a rear bearing 20R are fitted in a front housing 16 and a rear housing 18 provided on the front and rear ends of a stator 10, respectively. A rotor 12 integrally combined with an output shaft 14 supported for rotation by the bearings 20F and 20R is disposed radially opposite to the stator 10. The components 24G and 24S of a rotation detector for detecting the rotational position and/or the rotational speed of the output shaft 14 are provided in connection with the rear portion of the output shaft 14. In this embodiment, the front and rear ends of the output shaft 14 extend outside the front housing 16 and the rear housing 18, respectively.

If the electric motor provided with the output shaft 14 having front and rear ends respectively projecting outward from the front and rear housings is intended for use on a machine tool or the like, generally the motor is provided with labyrinth seals at the front and rear ends thereof, i.e., in the front end of the front housing 16 and in the rear end of the rear housing 18, respectively, to prevent the entry of oil mist and the like contained in the ambient atmosphere to the inside of the motor through gaps between the output shaft and the front housing 16, and between the output shaft and the rear housing 18. Accordingly, disk-like members 22F and 22R forming the labyrinth seals in combination with the front housing 16 and the rear housing 18 are fixed to the front and rear ends of the output shaft 14, respectively.

The balanced motor structure of the first embodiment of the present invention is characterized by balancing the motor by using the front disk-like member 22F and the rear disk-like member 22R, after the completion of the assembly of the motor.

Referring to Figs. 1 and 2, the disk-like member 22F (22R) is provided, in an outer surface thereof exposed to the outside, with a plurality of internally threaded holes (in this embodiment, sixteen internally threaded holes) 22A at the same radial positions and at equal angular intervals. The motor shown in Fig. 1 is rotated under its own drive power on a commercial field dynamic balancer, so that the rotational speed of the output shaft 14 is gradually increased to a maximum rotational speed of, for example, 15,000 r.p.m., to measure an imbalance thereof. Then, a balancing screw 26 capable of being engaged in the internally threaded hole 22A is screwed in the internally threaded hole 22A to an appropriate point at which the measured imbalance is dynamically adjusted to the least possible extent. At this stage, since the internally threaded holes 22a in both the front and rear disks 22F and 22R can be used for the balancing of the motor, the accuracy of the adjustment of the balance of the motor can be increased. The selective use of a plurality of kinds of balancing screws 26 having dif-

ferent lengths further improves the balancing accuracy. For an even more accurate balancing, portions of the disk-like members 22F and 22R may be drilled to desired depths to thereby remove any residual imbalance of the motor.

The construction of the rear portion of an electric motor shown in Fig. 3 incorporating a balancing structure according to the second embodiment of the present invention is different from that of the rear portion of the motor shown in Fig. 1. Namely, the rear end of an output shaft 14 terminates at the components 24G and 24S of a rotational speed detector, and a cooling fan 30 is disposed behind the output shaft 14. When the motor of this embodiment is to be dynamically balanced by the field balancing machine, the cooling fan 30 and the rear cover 18a of a rear housing 18 are temporarily removed. A front disk-like member 22F provided at the front end of the motor, and the gear member 24G of the rotational speed detector on the rear end are formed with internally threaded holes 22A at equal angular intervals, as shown in Fig. 2, and balancing screws 26 are screwed in the internally threaded holes 22A, to appropriate points, to thereby eliminate an imbalance measured by the balancing machine. Figure 4 illustrates the gear member 24G viewed in the direction of the arrow C.

Figure 5 illustrates an electric motor provided with a hollow output shaft 14', instead of the output shaft 14 of the motor of Fig. 1. The hollow output shaft 14' has a front end provided with a coupling member 34, and a rear end connected to a rotary joint 32. The present invention is also applicable to the balancing of the motor to be used in a mode such as illustrated in Fig. 5.

As apparent from the foregoing description, according to the present invention, the imbalance of an electric motor can be all but eliminated after completely assembling the motor, simply by using balancing screws. Since the disk-like members for the labyrinth seals and the gear member of the rotational speed detector for receiving the balancing screws are integral components of the electric motor, the use of the disk-like members for the labyrinth seals or the gear as the means of obtaining a dynamic balancing of the motor does not appreciably increase the manufacturing cost of the motor. Furthermore, since the motor is balanced after the completion of the assembly of the motor, the resultant balance of the motor is very accurate.

Claims

1. An apparatus comprising an electric motor having a rotating output shaft (14) provided with axially opposite external ends and a balancing structure comprising a respective disk member (22F, 22R, 24G) fixedly attached to each end of

the output shaft, each of the disk members having axially inner and outer surfaces formed perpendicular to the axis of rotation of the output shaft; characterised by the axially outer surfaces of each of said disk members having defined thereon a plurality of internally threaded holes (22A), the plurality of internally threaded holes being externally exposed so as to enable an operator to access the plurality of internally threaded holes, at least one of the disk members (22F,22R) being a labyrinth seal; and a plurality of balancing screws (26) of different lengths, wherein, in use, one of the screws is interchangeably screwed into a corresponding internally threaded hole (22A) in one of the two disk members (22F,22R,24G), for interchangeably balancing the output shaft of the electric motor.

2. An apparatus according to claim 1, wherein one of said disk members is a rotational speed detecting gear means (24G) having gear teeth formed its outer circumference.
3. An apparatus according to claim 1 or claim 2, wherein the internally threaded holes (22A) of at least one disk (22F,22R,22G) are arranged at equal radial distances from the axis of rotation of the output shaft, and at equal angular intervals.

Patentansprüche

1. Vorrichtung, welche einen Elektromotor umfaßt, der eine rotierende Abtriebswelle (14) besitzt, die mit einander in axialer Richtung gegenüberliegenden externen Enden versehen ist, und der eine Auswucht konstruktion aufweist, die an jedem Ende der Abtriebswelle ein fest montiertes Scheibenelement (22F, 22R, 24G) umfaßt, wobei jedes der Scheibenelemente in axialer Richtung eine innere und eine äußere Oberfläche aufweist und wobei diese Oberflächen senkrecht zur Drehachse der Abtriebswelle ausgerichtet sind, dadurch gekennzeichnet, daß die in axialer Richtung äußeren Oberflächen jedes der Scheibenelemente mit darin definierten Gewindebohrungen (22A) versehen sind, wobei die mehreren Gewindebohrungen nach außen offen sind, derart, daß ein Bedienungsmann Zugang zu den mehreren Gewindebohrungen hat, wobei mindestens eines der Scheibenelemente (22F, 22R) eine Labyrinthdichtung ist; und daß mehrere Auswuchtschrauben (26) unterschiedlicher Länge vorgesehen sind, wobei im Gebrauch eine der Schrauben auswechselbar in eine entsprechende Gewindebohrung (22A) in einem der beiden Scheibenelemente (22F, 22R, 24G) eingeschraubt wird, um die Abtriebswelle des Elektromotors austausch-

bar auszuwuchten.

2. Vorrichtung nach Anspruch 1, bei der eines der Scheibenelemente ein zu einem Drehgeber gehöriges Zahnrad (24G) ist, welches an seinem äußeren Umfang angeformte Zähne aufweist.
3. Vorrichtung nach Anspruch 1 oder 2, bei der die Gewindebohrungen (22A) mindestens einer Scheibe (22F, 22R, 22G) in gleichen radialen Abständen von der Drehachse der Abtriebswelle und in gleichen Winkelabständen angeordnet sind.

Revendications

1. Appareil comportant un moteur électrique ayant un arbre de sortie rotatif (14) pourvu d'extrémités externes axialement opposées et une structure d'équilibrage comportant un élément en forme de disque respectif (22F, 22R, 24G) fixé à chaque extrémité de l'arbre de sortie, chacun des éléments en forme de disque ayant des surfaces axialement interne et externe formées perpendiculairement à l'axe de rotation de l'arbre de sortie; caractérisé par le fait que les surfaces axialement externes de chacun des éléments en forme de disque ont plusieurs trous taraudés (22A) définis dedans, la multiplicité de trous taraudés étant exposée à l'extérieur de façon à permettre à un opérateur d'accéder à la multiplicité de trous taraudés, au moins un des éléments en forme de disque (22F, 22R) étant un joint à labyrinthe; et par plusieurs vis d'équilibrage (26) de différentes longueurs, une des vis, lors de l'utilisation, étant vissée de manière interchangeable dans un trou taraudé correspondant (22A) dans un des deux éléments en forme de disque (22F, 22R, 24G) afin d'équilibrer de manière interchangeable l'arbre de sortie du moteur électrique.
2. Appareil selon la revendication 1, dans lequel un des éléments en forme de disque est constitué par des moyens d'engrenage de détection de vitesse de rotation (24G) ayant des dents d'engrenage formées sur sa circonférence extérieure.
3. Appareil selon la revendication 1 ou la revendication 2, dans lequel les trous taraudés (22A) d'au moins un disque (22F, 22R, 22G) sont disposés à des distances radiales égales par rapport à l'axe de rotation de l'arbre de sortie, et à des intervalles angulaires égaux.

Fig.1

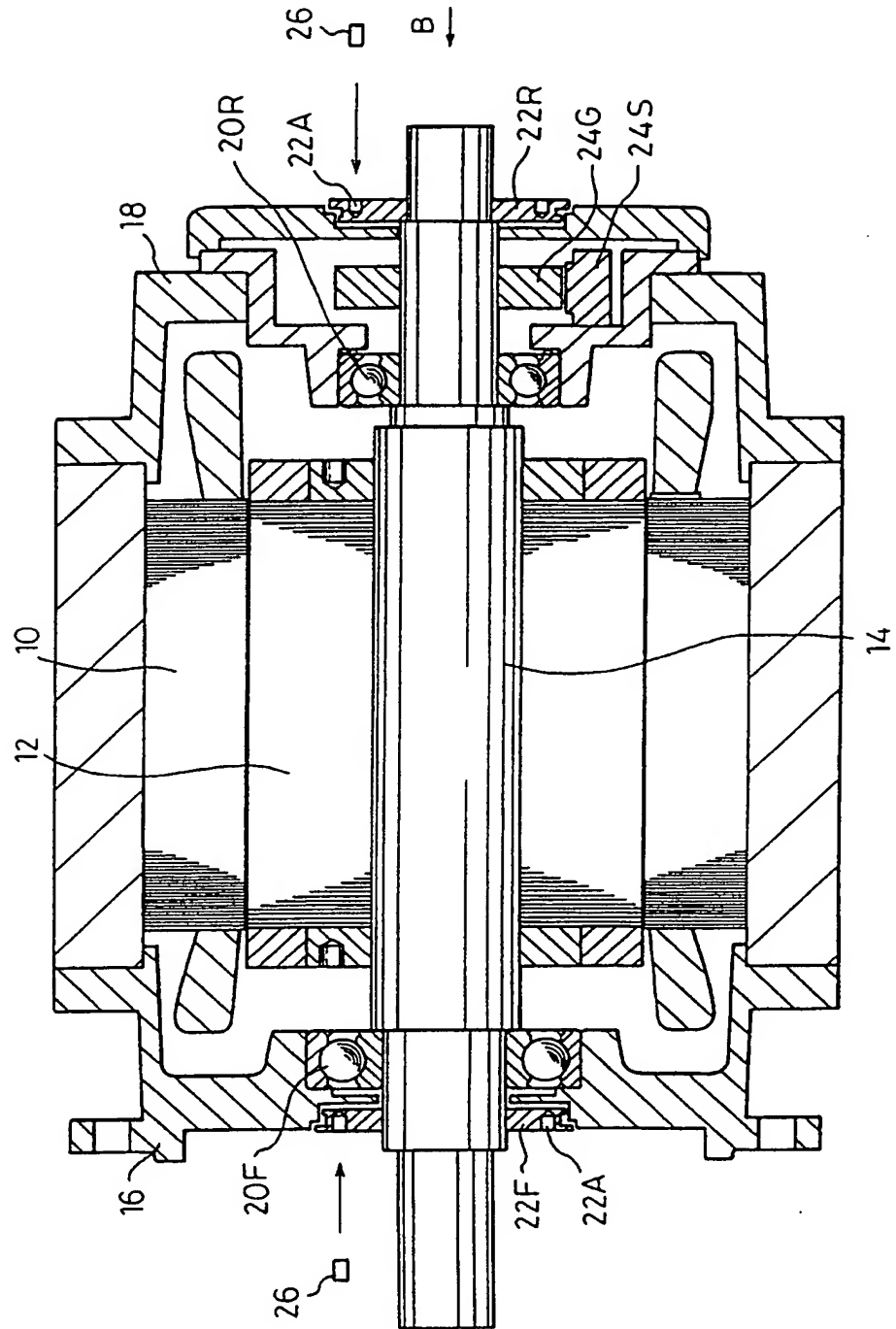


Fig. 2

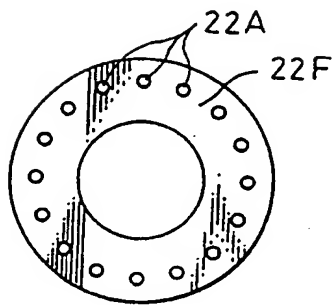


Fig. 4

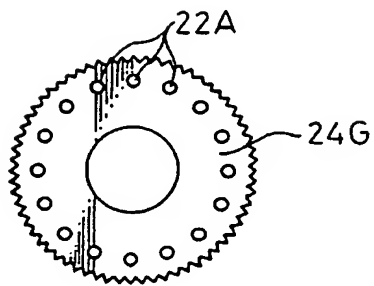


Fig. 3

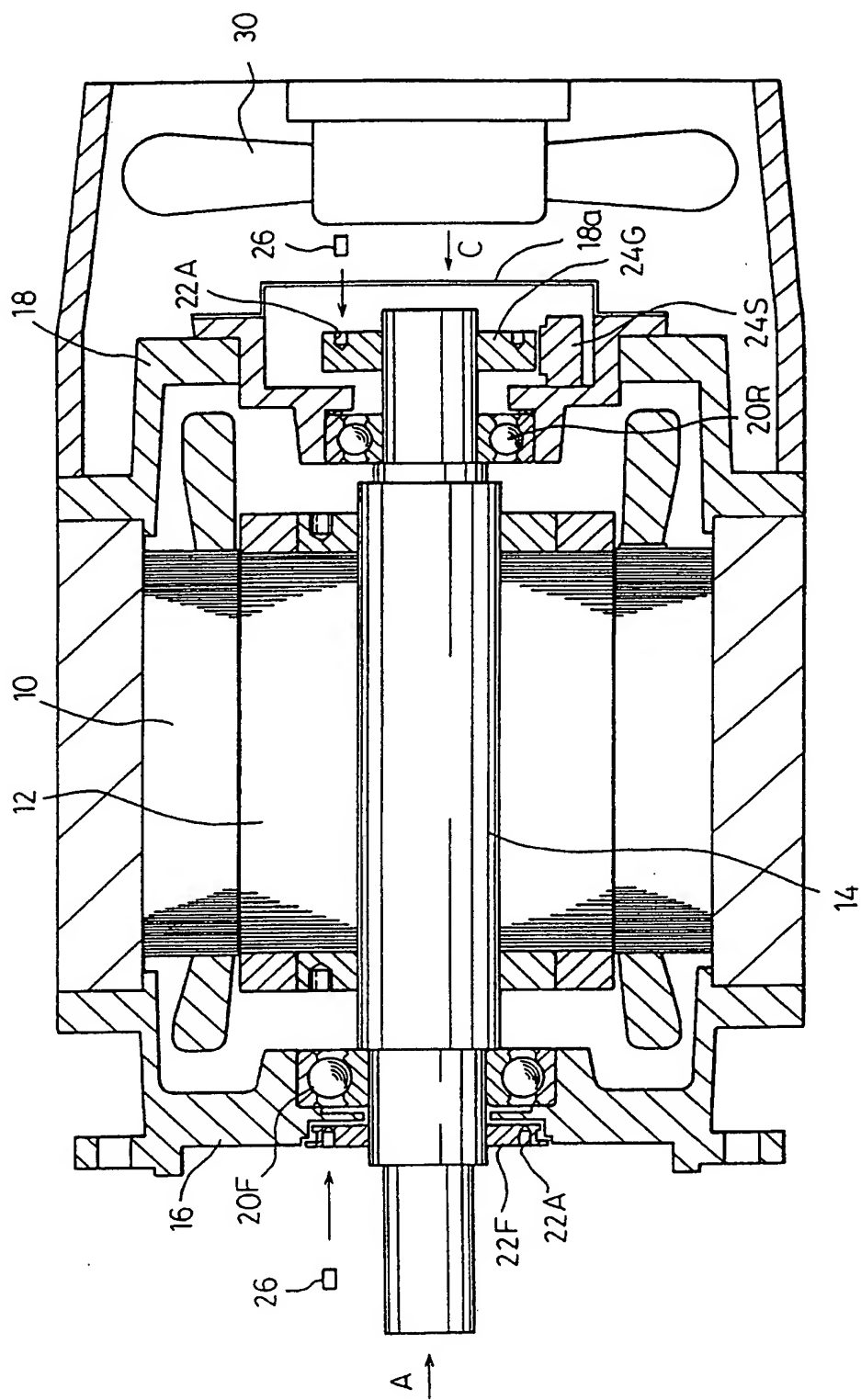


Fig. 5

